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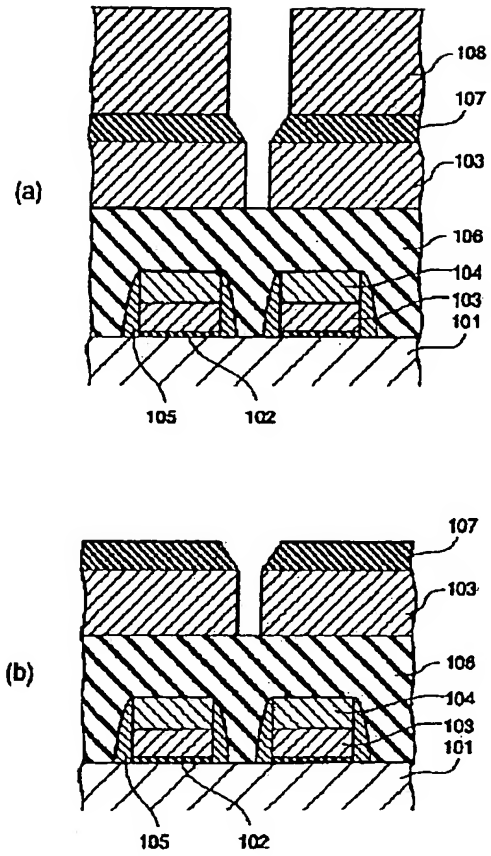
TITLE : FORMATION OF FINE CONNECTION HOLE



ABSTRACT : PROBLEM TO BE SOLVED: To provide a novel method for forming a fine connection hole which obtains a stable opening characteristic, while suppressing the increase of opening diameter in a mask.

SOLUTION: A mask layer 103 is formed on a substrate 101, having a film for forming the fine connection hole. A antireflection film 107 is formed on the mask layer 103. A hole, having a diameter decreasing toward the substrate 101 side, is formed in the antireflection film 107. A pattern for forming a fine connection hole is formed in the mask layer 103, using the reflection preventing film 107 having a hole. The fine connection hole is formed in the film, in accordance with the pattern for forming the fine connection hole.

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CLAIMS

[Claim(s)]
[Claim 1] The process which forms a mask layer on said film of the substrate which has the film which is the approach of forming a detailed connection hole in manufacture of a semiconductor device, and forms a detailed connection hole, The process which forms an antireflection film on said mask layer, and the process which forms the hole whose diameter is reduced toward a substrate side to said antireflection film, The formation approach of the detailed connection hole characterized by providing the process which forms the pattern for detailed connection hole formation in said mask layer using the antireflection film which has said hole, and the process which forms a detailed connection hole in said film according to the pattern for said detailed connection hole formation.
[Claim 2] Said antireflection film is the formation approach of the detailed connection hole according to claim 1 characterized by consisting of at least one chosen from the group which consists of SiOxNy, silicon, an organic spreading film ingredient, and amorphous carbon.
[Claim 3] Said mask layer is claim 1 characterized by consisting of two or more layers containing a refractory metal system layer. Or the formation approach of a detailed connection hole according to claim 2.
[Claim 4] The process which forms the pattern for detailed connection hole formation in said mask layer is the formation approach of the detailed connection hole according to claim 1 to 3 characterized by carrying out in the equipment made to generate low voltage and the high density plasma.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]

[Field of the Invention] This invention relates to the formation approach of a detailed connection hole especially about the dry etching approach applied in the manufacture field of a semiconductor device.
[0002]
[Description of the Prior Art] High integration and high-performance-izing of a semiconductor device follow on progressing, and the technical demand is still severer also about the dry etching of a silicon oxide (SiO2) system ingredient layer so that VLSI in recent years etc. may see. In it, the self-align contact (it abbreviates to SAC Self Alighed Contact and the following) technique which can make unnecessary the design margin on the mask for the alignment of a detailed connection hole (contact hole) formation process attracts attention.
[0003] Especially development of this SAC technique is activated in the generation after 0.25-micrometer rule, and there are several reasons in that background. One is the limit by the engine performance of an exposure machine, and another is a chip and the cutback of the area of a cel.
[0004] In the exposure machine for 0.25-micrometer mass production announced recently, since the lack of an improvement of the variation in the case of alignment of an exposure machine is the cause, especially the former means that trend maintenance of detailed-izing of a wiring layer is difficult. Therefore, since the variation in the case of alignment is large, a design margin becomes large. Consequently, wiring width of face will become thick, or an aperture becomes small too much and the problem of being unable to carry out opening arises. It is said that they are nonavoidable with 0.25-0.23-micrometer rule if that indication beginning to be in sight as for these problems and they go as it is from 0.3-micrometer rule.
[0005] The technique said to be able to make the design margin of this alignment unnecessary is the above-mentioned SAC technique. It is in the method of forming SAC partly, and all are dramatically effective in that a design margin is made unnecessary, although a process becomes complicated somewhat compared with the approach only using the conventional exposure.
[0006] Moreover, thin Si3 N4 when adopting the SAC approach The high etching technique of difficulty in which etching is stopped on the film is required. This problem is pair Si3 N4. As a high selection-ratio process, CF system protective coat is used and it is SiO2. It is supposed that it will be solved by preventing degradation of an etch rate by the activity of the high density plasma.
[0007]
[Problem(s) to be Solved by the Invention] However, it must be said with a SAC technique being total and seeing it that there are still many technical problems. Then, the approach of forming a detailed connection hole in a mask which is known from the former and which carried out shrink is also tried.
[0008] In this approach, first, as shown in drawing 12 (a), the polish recon film 203 used as a mask is formed on an interlayer insulation film 207, the polish recon sidewall film 210 is further formed on the both-sides side of the polish recon film 203, and shrink of the diameter of opening is carried out. Subsequently, if the conventional contact hole etching is performed to this, as shown in drawing 12 (b), the polish recon sidewall film 210 will retreat notably, the diameter of opening in a mask will be expanded, and the wiring short circuit 211 will be caused.
[0009] Since deposition of fluorocarbon will become superfluous within a detailed connection hole if pair mask high selection-ratio etching conditions are set up so that retreat of the polish recon sidewall film 210 may be prevented to this problem, etching will stop. Therefore, it is anxious for the formation approach of a new detailed connection hole that the stable opening property is acquired, controlling amplification of the diameter of opening in a mask.
[0010] It aims at offering the formation approach of a new detailed connection hole that the stable opening property is acquired, this invention being made in view of this point, and controlling amplification of the diameter of opening in a mask.
[0011]
[Means for Solving the Problem] In order to perform opening stabilized while controlling amplification

of the diameter of opening in a mask as a result of inquiring wholeheartedly in view of the above-mentioned trouble, this invention person performs taper etching to the antireflection film, and came to do header this invention for it being suitable to form the rectangle mask of a detailed connection hole for it as a mask.

[0012] Namely, the process which forms a mask layer on said film of the substrate which has the film which this invention is the approach of forming a detailed connection hole in manufacture of a semiconductor device, and forms a detailed connection hole, The process which forms an antireflection film on said mask layer, and the process which forms the hole whose diameter is reduced toward a substrate side to said antireflection film, The formation approach of the detailed connection hole characterized by providing the process which forms the pattern for detailed connection hole formation in said mask layer using the antireflection film which has said hole, and the process which forms a detailed connection hole in said film according to the pattern for said detailed connection hole formation is offered.

[0013] Since according to this configuration the polish recon sidewall which the path of a mask tends to expand is not formed, but taper etching of the antireflection film for mask processing of a detailed connection hole is carried out and this is imprinted, a detailed connection hole pattern can be formed in the layer which serves as a direct mask, without using a sidewall, and rectangle mask formation of an ideal can be realized. Consequently, the stable opening property can be acquired, controlling amplification of the diameter of opening in a mask.

[0014] In the formation approach of the detailed connection hole of this invention, it is desirable that it is characterized by including at least one chosen from the group which said antireflection film becomes from SiOxNy, silicon, an organic compound (an organic spreading film ingredient and amorphous carbon), and a refractory metal.

[0015] That is, as an antireflection film, if a desired taper configuration (configuration whose diameter is reduced toward a substrate side) is acquired, the thing of inorganic systems, such as SiOxNy and silicon, and the thing of organic systems, such as amorphous carbon, can be used. Taper etching of these film is fully possible by reducing an etching rate or making a side attachment wall deposit a resultant intentionally.

[0016] Moreover, in the formation approach of the detailed connection hole of this invention, it is desirable to consist of two or more layers in which a mask layer contains the layer which consisted of refractory metal system ingredients, for example, refractory metal silicide etc. According to this configuration, since the selection ratio at the time of etching of a detailed connection hole is highly securable, thickness of a mask layer can be made thin.

[0017] Moreover, in the formation approach of the detailed connection hole of this invention, it is desirable to perform the process which forms the pattern for detailed connection hole formation in a mask layer in the equipment made to generate low voltage and the high density plasma. According to this configuration, the path of opening in the mask layer of a detailed connection hole is controllable.

[0018]

[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained to a detail with reference to a drawing. Drawing 1 to drawing 3 is drawing having shown the plasma treatment equipment which can generate the high density plasma used for the approach of this invention. Drawing 1 shows an RF bias impression mold ECR plasma etching system. This equipment makes the microwave generated in the magnetron 11 reach the wafer 15 installed on the wafer stage 17 by the electrostatic chuck or the clamp 16 through the waveguide 12 and the quartz bell jar 13. In addition, 14 in drawing is a solenoid coil for forming a magnetic field in the quartz bell jar 13, and 18 is an RF generator.

[0019] Drawing 2 shows an MCR type (magnetic field containment mold reactor) etching system. This equipment impresses 13.56MHz RF to the side-attachment-wall electrode 20 made from a quartz from RF generator 18, and has the device which performs magnetic field containment with

the multipole magnet (not shown) which wound the up electrode 19 around the up electrode 19 or the chamber side attachment wall after discharging as ANO 1 DO, and forms the plasma of high density comparatively. Moreover, in this equipment, incidence ion energy is independently controllable by impressing substrate bias 450kHz to the wafer stage 17.
[0020] Drawing 3 shows an inductively-coupled-plasma (ICP) type etching system. This equipment has the device in which impress RF (13.56MHz) to the inductive-coupling coil 21 rolled in the shape of mosquito-repellant incense on the quartz plate 22 from RF generator 18, and the high density plasma is generated.
[0021] moreover -- although not illustrated -- the above -- also in which equipment, the wafer stage 17 possessing RF generator 18 has the structure where it can circulate through the refrigerant for temperature control (for example, FURORINATO), and the unipolar system electrostatic chuck is installed further.
[0022] Next, the concrete operation gestalt of this invention is explained.
(Operation gestalt 1) As shown in drawing 4 (a), after forming gate oxide 102 7nm in thickness by thermal oxidation on the Si substrate 101 first, on it, with for example, the reduced pressure CVD method, it is 100nm in thickness about the phosphorus dope polysilicon contest film 103, and the WSix film 104 was further formed for example, by the plasma-CVD method on it at 100nm in thickness.
[0023] Subsequently, the gate pattern of a request of 0.35-micrometer width of face was formed to the above-mentioned sample under the conditions shown below using an excimer stepper. Furthermore, the LDD sidewall film 105 was formed in the side attachment wall of the gate electrode which consists of polish recon film 103 and WSix film 104.
[0024] (The WSix film 104 and polish recon film 103 etching step)
Etching system :ECR type gas : Cl2 / O2 =75 / 6sccm pressure : 0.4Pamu wave output : 1200WRF bias : 70W (WSix film), 50W (polish recon film)
Wafer temperature : 20-degree-C over-etching : 40% [0025]
(LDD sidewall film 105 formation step)
Etching system : anode couple parallel plate type gas : CF4 / Ar=40/[CHF3 /] 40 / 800sccm pressure : 200PaRF bias : 500W (380kHz)
Wafer temperature : 50-degree-C over-etching : 5% [0026] Subsequently, as shown in drawing 4 (b), on this, it considered as the interlayer insulation film 106, and it formed by 600nm in thickness for example, by ordinary pressure CVD and the reflow method, and the polish recon film 103 was formed for SiO2 film by 300nm in thickness with the reduced pressure CVD method. Then, as shown in drawing 4 (c), the SiOxNy film was formed by 100nm in thickness for example, by the plasma-CVD method as an antireflection film 107 on it.
[0027] Subsequently, as shown in drawing 5 (a), the photoresist film 108 was formed on this and the contact hole (detailed connection hole) pattern which has opening of the diameter of 0.25 micrometer on the photoresist film 108 by the KrF excimer stepper was formed. At that time, as shown in drawing 5 (a), the 0.05-micrometer hole patterning gap had arisen [the location which forms a contact hole, and the location of opening of a contact hole pattern] rightward.
[0028] Then, when etching (taper etching) of the antireflection film 107 and the polish recon film 103 was performed on condition that the following using the etching system of the ECR type shown, for example in drawing 1 , it became the structure shown in drawing 6 (a) through the structure shown in drawing 5 (b).
[0029] (Antireflection-film 107 etching step)
Gas :Cl2 / O2 =75 / 8sccm pressure : 0.4Pamu wave output : 1200W (2.45GHz)
RF bias : 50W (800kHz)
Wafer temperature : 20-degree-C over-etching : 10% [0030]
(Polish recon film 103 etching step)
Gas :Cl2 / O2 =75 / 2sccm pressure : 0.4Pamu wave output : 1200W (2.45GHz)

RF bias : 70W (800kHz)
Wafer temperature : 20-degree-C over-etching : 30% [0031] Then, as shown in drawing 6 (b), the commercial ashing device removed the photoresist film 108. As shown in drawing 6 (b), with this structure, the antireflection film 107 which has opening of a taper configuration serves as a mask, and the hole pattern which has opening of the diameter of 0.1 micrometer on the polish recon film 103 is formed.
[0032] By the magnetron type etching system of marketing to this, when the interlayer insulation film 106 was etched into the last on condition that the following, it became the structure shown at drawing 7 (b) through the structure of drawing 7 (a) at it. That is, the antireflection film 107 was removed during etching of an interlayer insulation film 106.
[0033] (Interlayer insulation film 106 etching step)
Gas :C4 F8/CO/Ar=5/100/300sccm pressure : 5.0PaRF bias : 1500W (13.56MHz)
Wafer temperature : 20-degree-C over-etching : 50% [0034] Since the diameter of opening of a mask was maintained by 0.1 micrometers during etching, in this structure, the contact hole of a vertical configuration can be formed, so that drawing 7 (b) may show. Therefore, by the conventional approach, although the 0.05-micrometer doubling gap arose by the approach of this operation gestalt the place from which the diameter of opening in a mask is expanded, and a wiring short circuit is started, the wiring short circuit did not take place at all. Thus, according to this operation gestalt, formation of the detailed connection hole of a good configuration could be realized, and more than breakdown voltage 50V has been attained as a proof-pressure property.
[0035] (Operation gestalt 2) The sample of the structure shown in drawing 4 R> 4 (a) like the operation gestalt 1 was produced. Subsequently, as shown in drawing 4 R> 4 (b), on this, it considered as the interlayer insulation film 106, and it formed by 600nm in thickness for example, by ordinary pressure CVD and the reflow method, and the polish recon film 103 was formed for SiO2 film by 300nm in thickness with the reduced pressure CVD method. Then, as shown in drawing 4 (c), on it, spin coat spreading of the organic system antireflection film (for example, product made from Brewer Science DUV-18) was carried out as an antireflection film 107, and it formed by 120nm in thickness.
[0036] Subsequently, as shown in drawing 5 (a), the photoresist film 108 was formed on this and the contact hole (detailed connection hole) pattern which has opening of the diameter of 0.25 micrometer on the photoresist film 108 by the KrF excimer stepper was formed. At that time, as shown in drawing 5 (a), the 0.05-micrometer hole patterning gap had arisen [the location which forms a contact hole, and the location of opening of a contact hole pattern] rightward.
[0037] Then, when etching (taper etching) of the antireflection film 107 and the polish recon film 103 was performed on condition that the following using the etching system of the MCR type shown, for example in drawing 2 , it became the structure shown in drawing 6 (a) through the structure shown in drawing 5 (b).
[0038] (Antireflection-film 107 etching step)
Gas :Ar/O2 =100 / 10sccm pressure : 0.4Pa source mode output : 1200W (13.56MHz)
RF bias : 50W (450kHz)
Wafer temperature : 70-degree-C over-etching : 5% [0039]
(Polish recon film 103 etching step)
Gas :Cl2 =50sccm pressure : 0.4Pa source mode output : 1200W (13.56MHz)
RF bias : 70W (450kHz)
Wafer temperature : 70-degree-C over-etching : 5% [0040] Then, as shown in drawing 7 (a), the commercial ashing device removed the photoresist film 108. The antireflection film 107 of an organic system was also removed on the occasion of this ashing processing. Also in this case, as shown in drawing 6 (b), the antireflection film 107 which has opening of a taper configuration became a mask, and the hole pattern which has opening of the diameter of 0.1 micrometer on the polish recon film 103 was formed.

[0041] By the magnetron type etching system of marketing to this, when the interlayer insulation film 106 was etched into the last on condition that the following, it became the structure shown at drawing 7 (b) at it.
[0042] (Interlayer insulation film 106 etching step)
Gas :C4 F8/CO/Ar=5/100/300sccm pressure : 5.0PaRF bias : 1500W (13.56MHz)
Wafer temperature : 20-degree-C over-etching : 50% [0043] Since the diameter of opening of a mask was maintained by 0.1 micrometers during etching, in this structure, the contact hole of a vertical configuration can be formed, so that drawing 7 (b) may show. Therefore, by the conventional approach, although the 0.05-micrometer doubling gap arose by the approach of this operation gestalt the place from which the diameter of opening in a mask is expanded, and a wiring short circuit is started, the wiring short circuit did not take place at all. Thus, according to this operation gestalt, formation of the detailed connection hole of a good configuration could be realized, and more than breakdown voltage 50V has been attained as a proof-pressure property.
[0044] (Operation gestalt 3) As shown in drawing 8 (a), after forming gate oxide 102 7nm in thickness by thermal oxidation on the Si substrate 101 first, on it, with for example, the reduced pressure CVD method, it is 100nm in thickness about the phosphorus dope polysilicon contest film 103, and the WSix film 104 was further formed for example, by the plasma-CVD method on it at 100nm in thickness.
[0045] Subsequently, the gate pattern of a request of 0.35-micrometer width of face was formed to the above-mentioned sample under the conditions shown below using an excimer stepper. Furthermore, the LDD sidewall film 105 was formed in the side attachment wall of the gate electrode which consists of polish recon film 103 and WSix film 104.
[0046] (The WSix film 104 and polish recon film 103 etching step)
Etching system :ECR type gas : Cl2 / O2 =75 / 6sccm pressure : 0.4Pamu wave output : 1200WRF bias : 70W (WSix film), 50W (polish recon film)
Wafer temperature : 20-degree-C over-etching : 40% [0047]
(LDD sidewall film 105 formation step)
Etching system : anode couple parallel plate type gas : CF4 / Ar=40/[CHF3 /] 40 / 800sccm pressure : 200PaRF bias : 500W (380kHz)
Wafer temperature : 50-degree-C over-etching : 5% [0048] subsequently, it is shown in drawing 8 (b) -- as -- a this top -- as an interlayer insulation film 106 -- SiO2 film -- for example, ordinary pressure CVD and the reflow method -- 600nm in thickness -- the polish recon film 103 -- sequential formation for example, of the WSix film was carried out [50nm in thickness] by 70nm in thickness by the plasma-CVD method as refractory metal system film with the reduced pressure CVD method. Then, as shown in drawing 4 (c), the SiOxNy film was formed by 100nm in thickness for example, by the plasma-CVD method as an antireflection film 107 on it.
[0049] Subsequently, as shown in drawing 9 (a), the photoresist film 108 was formed on this and the contact hole (detailed connection hole) pattern which has opening of the diameter of 0.25 micrometer on the photoresist film 108 by the KrF excimer stepper was formed. At that time, as shown in drawing 9 (a), the 0.05-micrometer hole patterning gap had arisen [the location which forms a contact hole, and the location of opening of a contact hole pattern] rightward.
[0050] Then, when antireflection film 107 / refractory metal system film 109 / polish recon film 103 was etched on condition that the following using the etching system of the ICP type shown, for example in drawing 3 (taper etching), it became the structure shown in drawing 10 (a) through the structure shown in drawing 9 (b).
[0051] (Antireflection-film 107 etching step)
Gas :Cl2 / O2 =50 / 10sccm pressure : 0.4Pa source mode output : 300W (13.56MHz)
RF bias : 50W (13.56MHz)
Wafer temperature : 70-degree-C over-etching : 20% [0052] (109/polish recon film 103 etching step of refractory metal system film)

Gas :Cl2 / O2 =50 / 5sccm pressure : 0.4Pamu wave output : 400W (13.56MHz)
RF bias : 50W (13.56MHz)
Wafer temperature : 70-degree-C over-etching : 20% [0053] Then, as shown in drawing 10 (b), the commercial ashing device removed the photoresist film 108. As shown in drawing 10 (b), with this structure, the antireflection film 107 which has opening of a taper configuration serves as a mask, and the hole pattern which has opening of the diameter of 0.1 micrometer on refractory metal system film 109 / polish recon film 103 is formed.
[0054] By the magnetron type etching system of marketing to this, when the interlayer insulation film 106 was etched into the last on condition that the following, it became the structure shown at drawing 11 (b) through the structure of drawing 11 (a) at it. That is, the antireflection film 107 on the refractory metal system film 109 was removed during etching of an interlayer insulation film 106.
[0055] (Interlayer insulation film 106 etching step)
Gas :C4 F8/CO/Ar=5/100/300sccm pressure : 5.0PaRF bias : 1500W (13.56MHz)
Wafer temperature : 20-degree-C over-etching : 50% [0056] Since the diameter of opening of a mask was maintained by 0.1 micrometers during etching, in this structure, the contact hole of a vertical configuration can be formed, so that drawing 11 (b) may show. Therefore, by the conventional approach, although the 0.05-micrometer doubling gap arose by the approach of this operation gestalt the place from which the diameter of opening in a mask is expanded, and a wiring short circuit is started, the wiring short circuit did not take place at all. Thus, according to this operation gestalt, formation of the detailed connection hole of a good configuration could be realized, and more than breakdown voltage 50V has been attained as a proof-pressure property.
[0057] (Operation gestalt 4) The sample of the structure shown in drawing 8 R> 8 (a) like the operation gestalt 3 was produced. subsequently, it is shown in drawing 8 R> 8 (b) -- as -- a this top -- as an interlayer insulation film 106 -- SiO2 film -- for example, ordinary pressure CVD and the reflow method -- 600nm in thickness -- the polish recon film 103 -- sequential formation for example, of the WSix film was carried out [50nm in thickness] by 70nm in thickness by the plasma-CVD method as refractory metal system film with the reduced pressure CVD method. Then, as shown in drawing 8 (c), on it, spin coat spreading of the organic system antireflection film (for example, product made from Brewer Science DUV-18) was carried out as an antireflection film 107, and it formed by 120nm in thickness.
[0058] Subsequently, as shown in drawing 9 (a), the photoresist film 108 was formed on this and the contact hole (detailed connection hole) pattern which has opening of the diameter of 0.25 micrometer on the photoresist film 108 by the KrF excimer stepper was formed. At that time, as shown in drawing 9 (a), the 0.05-micrometer hole patterning gap had arisen [the location which forms a contact hole, and the location of opening of a contact hole pattern] rightward.
[0059] Then, when antireflection film 107 / refractory metal system film 109 / polish recon film 103 was etched on condition that the following using the etching system of the ECR type shown, for example in drawing 1 (taper etching), it became the structure shown in drawing 10 (a) through the structure shown in drawing 9 (b).
[0060] (Antireflection-film 107 etching step)
Gas :Cl2 / O2 =20 / 40sccm pressure : 0.4Pamu wave output : 1000W (2.45GHz)
RF bias : 70W (800kHz)
Wafer temperature : 20-degree-C over-etching : 10% [0061] (109/polish recon film 103 etching step of refractory metal system film)
Gas :Cl2 / O2 =80 / 10sccm pressure : 0.4Pamu wave output : 1000W (2.45GHz)
RF bias : 70W (800kHz)
Wafer temperature : 20-degree-C over-etching : 30% [0062] Then, as shown in drawing 11 (a), the commercial ashing device removed the photoresist film 108. The antireflection film 107 of an organic system was also removed on the occasion of this ashing processing. Also in this case, as shown in drawing 10 (b), the antireflection film 107 which has opening of a taper configuration became a mask,

and the hole pattern which has opening of the diameter of 0.1 micrometer on refractory metal system film 109 / polish recon film 103 was formed.
[0063] By the magnetron type etching system of marketing to this, when the interlayer insulation film 106 was etched into the last on condition that the following, it became the structure shown at drawing 11 (b) at it.
[0064] (Interlayer insulation film 106 etching step)
Gas :C4 F8/CO/Ar=5/100/300sccm pressure : 5.0PaRF bias : 1500W (13.56MHz)
Wafer temperature : 20-degree-C over-etching : 50% [0065] Since the diameter of opening of a mask was maintained by 0.1 micrometers during etching, in this structure, the contact hole of a vertical configuration can be formed, so that drawing 11 (b) may show. Therefore, by the conventional approach, although the 0.05-micrometer doubling gap arose by the approach of this operation gestalt the place from which the diameter of opening in a mask is expanded, and a wiring short circuit is started, the wiring short circuit did not take place at all. Thus, according to this operation gestalt, formation of the detailed connection hole of a good configuration could be realized, and more than breakdown voltage 50V has been attained as a proof-pressure property.
[0066] Although the four above-mentioned operation gestalten were explained about this invention, this invention is not limited to an above-mentioned operation gestalt, and it cannot be overemphasized that process conditions, such as a source of the plasma, and an equipment configuration, sample structure, etching gas, can be suitably chosen in the range which does not deviate from the main point of this invention.
[0067]
[Effect of the Invention] As explained above, the formation approach of the detailed connection hole of this invention is a new approach by which the stable opening property is acquired, controlling amplification of the diameter of opening in a mask, since opening is formed in a mask layer using the antireflection film which has opening of a taper configuration.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the outline sectional view showing the etching system of the ECR type used in the approach of this invention.
[Drawing 2] It is the outline sectional view showing the etching system of the MCR type used in the approach of this invention.
[Drawing 3] It is the outline sectional view showing the etching system of the ICP type used in the approach of this invention.
[Drawing 4] It is the schematic diagram showing the sample cross-section structure for explaining the operation gestalt 1 and the operation gestalt 2 in this invention.

[Drawing 5] It is the schematic diagram showing the sample cross-section structure for explaining the operation gestalt 1 and the operation gestalt 2 in this invention.
[Drawing 6] It is the schematic diagram showing the sample cross-section structure for explaining the operation gestalt 1 and the operation gestalt 2 in this invention.
[Drawing 7] It is the schematic diagram showing the sample cross-section structure for explaining the operation gestalt 1 and the operation gestalt 2 in this invention.
[Drawing 8] It is the schematic diagram showing the sample cross-section structure for explaining the operation gestalt 3 and the operation gestalt 4 in this invention.
[Drawing 9] It is the schematic diagram showing the sample cross-section structure for explaining the operation gestalt 3 and the operation gestalt 4 in this invention.
[Drawing 10] It is the schematic diagram showing the sample cross-section structure for explaining the operation gestalt 3 and the operation gestalt 4 in this invention.
[Drawing 11] It is the schematic diagram showing the sample cross-section structure for explaining the operation gestalt 3 and the operation gestalt 4 in this invention.
[Drawing 12] It is a schematic diagram for explaining the formation approach of the conventional detailed connection hole.
[Description of Notations]
11 [-- Solenoid coil,] -- A magnetron, 12 -- A waveguide, 13 -- A quartz bell jar, 14 15 [-- RF generator,] -- A wafer, 16 -- A clamp, 17 -- A wafer stage, 18 19 [-- Quartz plate,] -- An up electrode, 20 -- A side-attachment-wall electrode, 21 -- An inductive-coupling coil, 22 101 [-- The WSix film, 105 / -- The LDD sidewall film, 106 / -- An interlayer insulation film, 107 / -- The antireflection film, 108 / -- The photoresist film, 109 / -- Refractory metal system film.] -- Si substrate, 102 -- Gate oxide, 103 -- The polish recon film, 104

[Translation done.]

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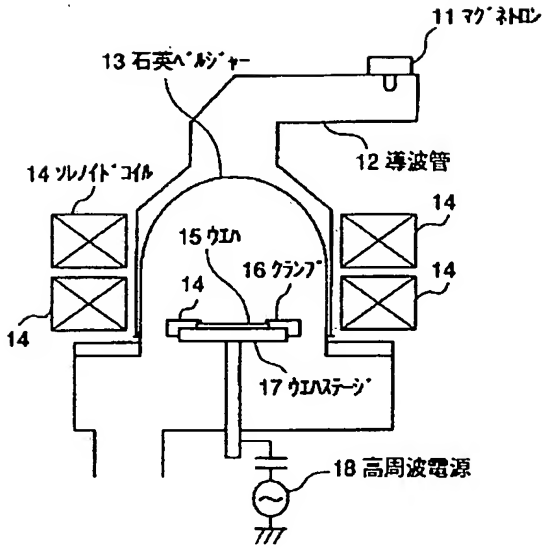
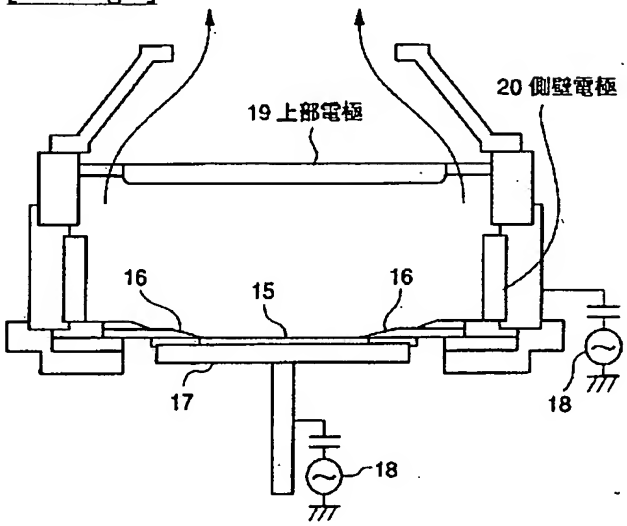
DRAWINGS

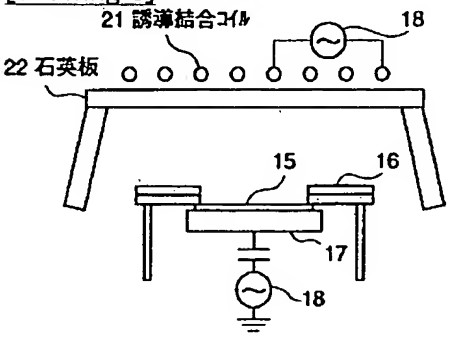
[Drawing 1]



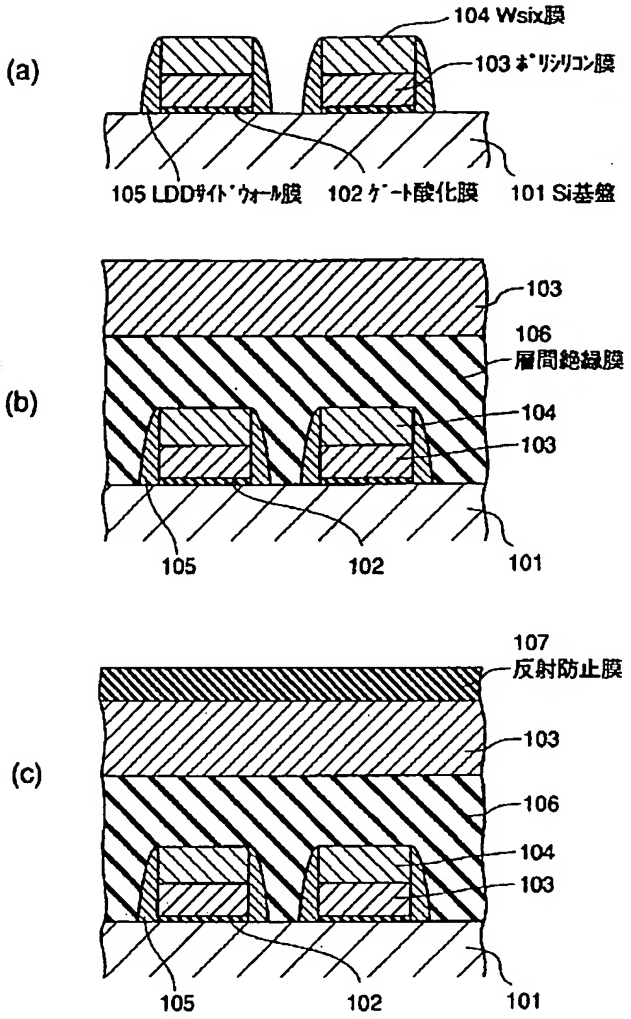
[Drawing 2]



[Drawing 3]

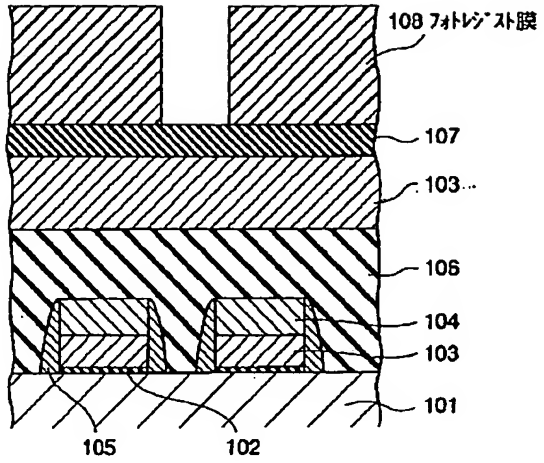


[Drawing 4]

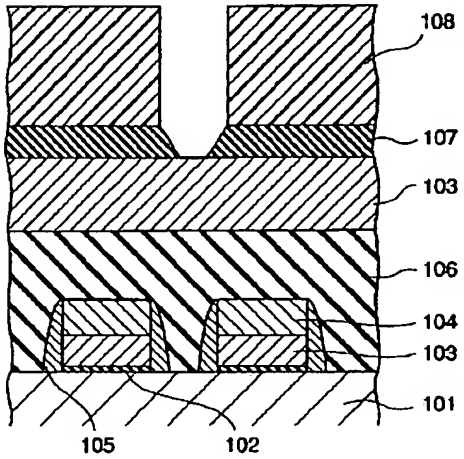

(a)
104 Wsix膜
103 ポリシリコン膜
105 LDDサイドウォール膜
102 ゲート酸化膜
101 Si基盤
(b)
103
106
層間絶縁膜
104
103
105
102
101
(c)
107
反射防止膜
103
106
104
103
105
102
101

[Drawing 5]

(a)

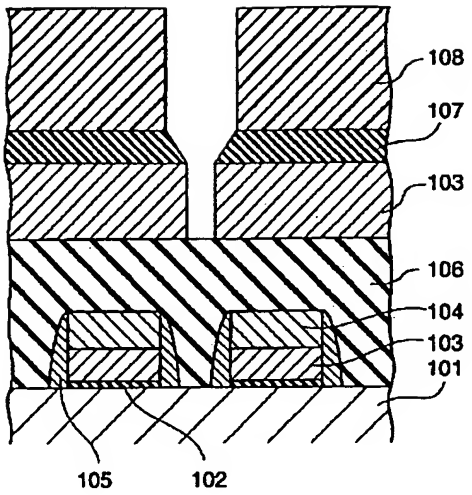

108 フォトレジスト膜
107
103
106
104
103
101
105
102

(b)

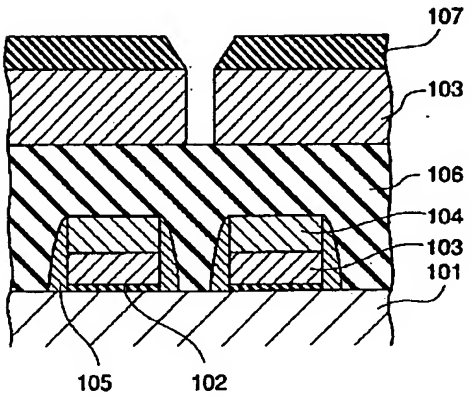

108
107
103
106
104
103
101
105
102

[Drawing 6]

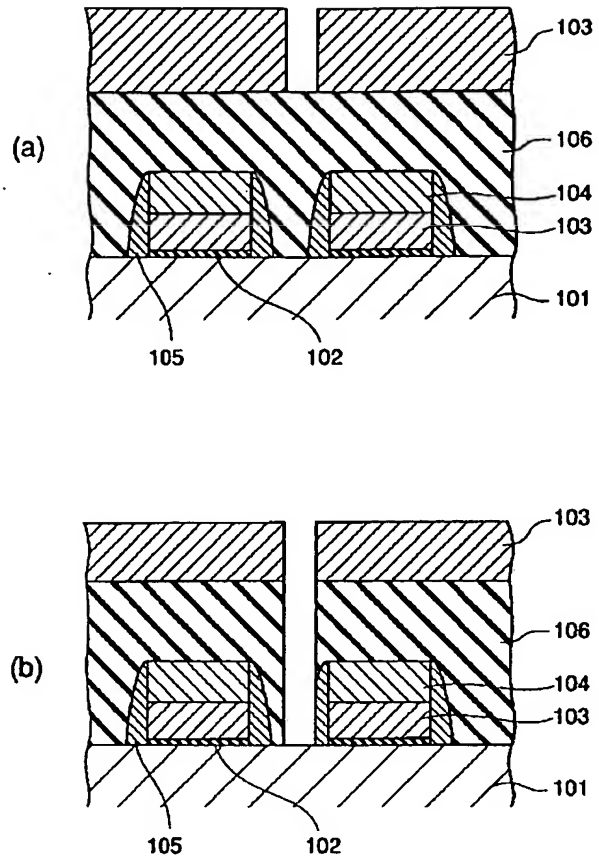
(a)


108
107
103
106
104
103
101
105
102

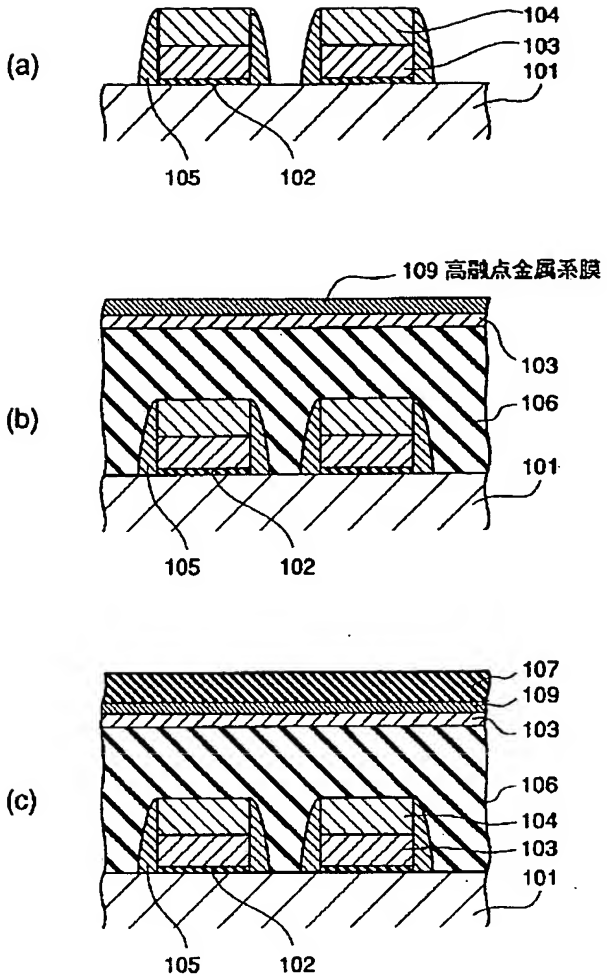
(b)


107
103
106
104
103
101
105
102

[Drawing 7]

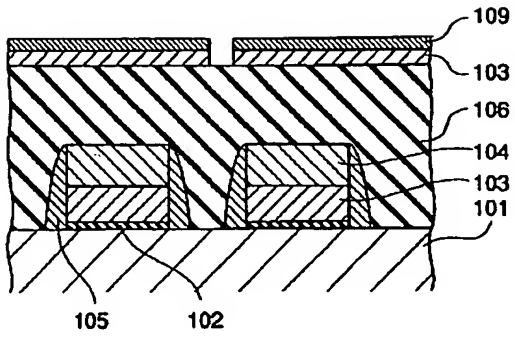


[Drawing 8]

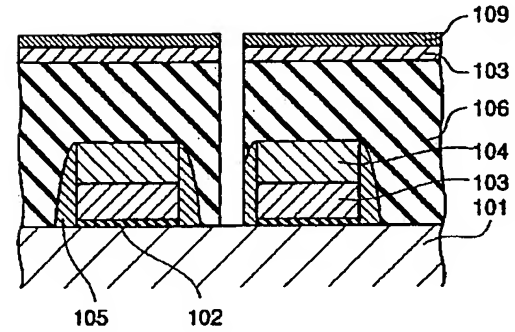

(a)
104
103
101
105
102
(b)
109 高融点金属系膜
103
106
101
105
102
(c)
107
109
103
106
104
103
101
105
102

[Drawing 11]

(a)

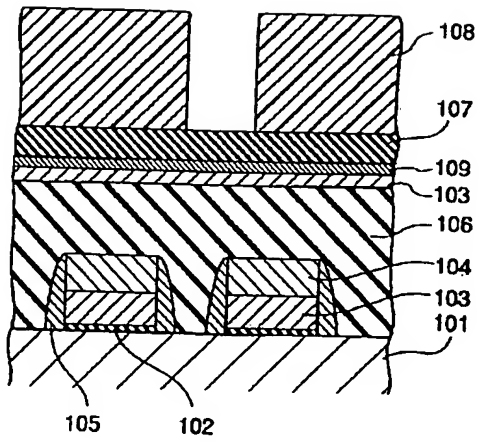


(b)

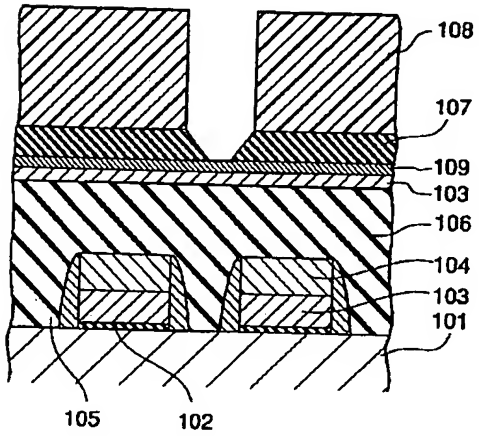


[Drawing 9]

(a)



(b)



[Drawing 10]